

Application No. 10/609,486

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January 26, 2005

REMARKS

It appears to the applicant that the Examiner's rejection of the original claims of the present application stems from an unintentional ambiguity in the term "surface coil". The applicant had intended this term to mean a coil which exists in its entirety on a single surface. The coils disclosed by Gris et. al. and Karrer et. al. do not suit this definition as each turn of their coils exists on four different surfaces. These surfaces are the two opposite sides of a circuit board and the internal cylindrical surfaces of the two vias.

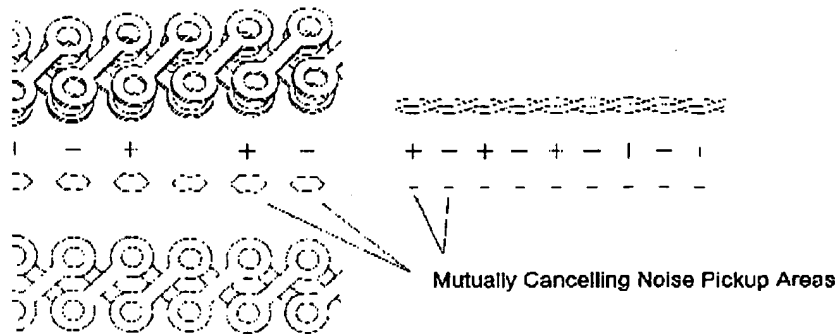
Both Gris et. al. and Karrer et. al. use a circuit board oriented orthogonally to the conductor with the current to be measured, on which to produce their coil windings and the interconnections between coil windings. The problem with this orthogonal orientation is two-fold. Firstly, coil loops cannot be easily nested, and this reduces the amount of signal available from the sensor. Secondly, noise capture zones, particularly in the interconnections, on this orthogonal board are inevitable, leading to a further reduced signal-to-noise ratio. As Karrer et. al. have observed, (column 1, lines 28 - 36, and column 3, lines 45 - 53), Gris et. al. have not adequately addressed the problem of sensitivity to transverse magnetic fields. Karrer et. al. have attempted to address this problem through careful design of the orthogonal circuit board, such that every noise pickup area on the board is matched by a corresponding area, equal in size, but having a response to noise that is opposite in polarity. As a result, the effect of these two areas should in theory cancel out any response to noise resulting from transverse fields. The problem with this in practice is that perfect cancellation requires uniform magnetic fields, but magnetic fields are usually non-uniform, leading to imperfect cancellation.

The present invention presents a solution to the problem described above by completely eliminating the orthogonal circuit board, and instead using surface coils on circuit boards with a radial/axial orientation, interconnected with twisted pair wire.

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**Diagram 1**  
Mutually cancelling noise pickup areas can be smaller and closer together with twisted pair wire.

When magnetic fields are non-uniform, the best cancellation, and therefore the best immunity to noise from transverse magnetic fields, is achieved when the mutually cancelling regions are as small as possible and as close together as possible.

As can be seen from Diagram 1, this is better achieved through the use of twisted pair wire. With twisted pair wire, the noise pickup regions can be much smaller and much closer together. Thus, the present invention provides a means for achieving superior noise immunity.

In addition, the radial/axial orientation of the surface coil surfaces makes it easy to nest the loops in each coil, leading to a much more efficient signal pickup. This combined with a lower noise pickup can provide a better signal-to-noise ratio.

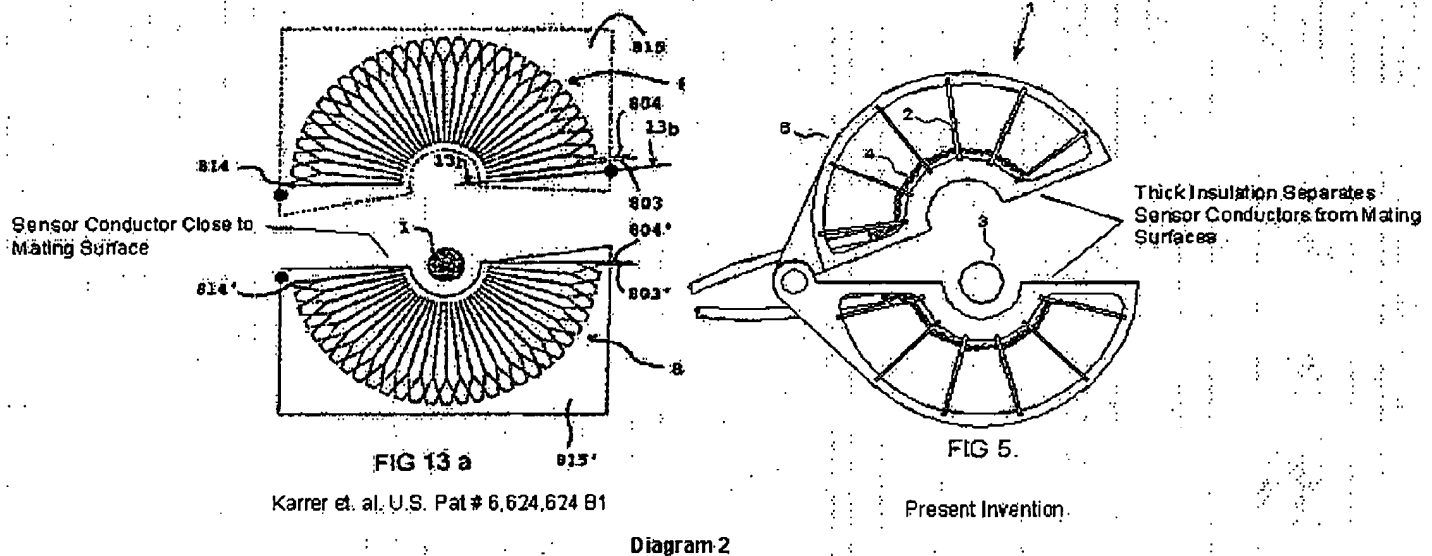
For applications where noise immunity is not as important, but cost may be an issue, the present invention provides a sensor wherein the interconnections and surface coils are made together with tracks on a single one-piece flexible circuit board which is then bent into the radial/axial oriented sections which form the sensor. While Karrer et. al. do present the use of flexible circuit board, they do not do so in conjunction with radial/axial oriented surface coils. Rather they only do it in conjunction with orthogonal circuit board type sensors, and this type of sensor is quite different from the present invention. In the case of Karrer et. al. the function of the flexible circuit board is to allow entry of a larger conductor into the measurement cavity than would otherwise be possible. In the present invention, the function of the flexible circuit board is to provide ease of manufacturing.

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While it is acknowledged that clamp-on current sensors are not in themselves new, the present invention does have the advantage of being able to provide a sizeable separation distance between the mating surfaces and the sensor conductors, as is shown in Diagram 2. Neither Fernandes nor Karrer et. al. teach how this separation might be achieved while still maintaining the benefits of the toroidal geometry. In fact in Karrer et. al. Figures 13a, and 16, it is quite evident that Karrer et. al. have sensor conductors very close to the mating surfaces.



The problem with this is that the sensor is more prone to damage, particularly when installing the sensor to measure currents in high voltage bare conductors. In such cases, a spark from the high voltage conductor to the sensor conductor could easily damage the sensor and its associated electronics.

In view of all the above, the applicant believes that the present invention is not obvious and has not been anticipated by the prior art. To remove the ambiguity described earlier, and to better distinguish the present invention from the prior art, the applicant has reworded these features in new claims 21 to 40. The applicant therefore respectfully requests reconsideration of the objection.

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Favourable reconsideration and allowance of this application are respectfully requested.

A Claim Fee Calculation Sheet authorizing payment of any excess claim fees is enclosed. The Commissioner is authorized to charge any deficiency or credit any overpayment in the fees for same to our Deposit Account No. 500663. A signed copy of this page is enclosed if required for this purpose.

A Petition for an Extension of Time requesting an extension of three months for filing the subject response is enclosed. The Commissioner is authorized to charge any deficiency or credit any overpayment in the fees for same to our Deposit Account No. 500663. A signed copy of this page is enclosed if required for this purpose.

Executed at Toronto, Ontario, Canada, on January 26, 2005.

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Encl      Petition for Extension of Time (in duplicate)  
            Claim Fee Calculation sheet (in duplicate)

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**COPY**

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